Gastric Emptying Study: Liquids

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RATIONALE

Gastric emptying is a simpler process for liquids than solids because liquids do not need to be mixed with gastric juices and ground into small particles to pass through the pyloric sphincter. As liquids enter the stomach, it relaxes to accommodate the volume. Then, the stomach's smooth muscle contracts, creating a pressure gradient between the stomach and pylorus that pushes liquid through the pyloric sphincter into the duodenum.

The volume of liquid is the main determinant of the rate of liquid gastric emptying. The larger the volume of liquid, the quicker the rate of emptying. Liquid begins leaving the stomach almost as soon as it reaches the stomach and usually empties in approximately 30 min.

CLINICAL INDICATIONS

- Determination of gastric emptying rate.
- Evaluation of mechanical and anatomic obstruction.
- Evaluation of nausea, vomiting, upper abdominal discomfort, bloating, gastroesophageal reflux/chronic aspiration, and early satiety.
- Evaluation of weight loss.
- Evaluation of rapid gastric emptying.

CONTRAINDICATIONS

- Hypoglycemia with blood glucose level less than 40 mg/dL.
- Hyperglycemia with blood glucose level greater than 275 mg/dL.
- Improper preparation of the patient for the procedure.

- Pregnancy or breastfeeding. Pregnancy must be excluded according to local institutional policy. If the patient is breastfeeding, radiation safety instructions should be provided.
- Recent nuclear medicine study (radiopharmaceutical-dependent).

PATIENT PREPARATION/EDUCATION

- The patient should have nothing to eat or drink overnight or 4–6 h before the test.
- The patient may not smoke the morning of the test or until after test completion.
- If the patient has insulin-dependent diabetes:
 - The patient should bring a blood glucose monitor and insulin to the test.
 - The blood glucose level should be determined and recorded before meal ingestion and should ideally be less than 200 mg/dL.
 - If more than 275 mg/dL, a small dose of shortacting insulin should be administered before meal ingestion, and the patient should be monitored. The meal should be withheld until the blood glucose level falls below 275 mg/dL.
- Studies on menstruating patients should be performed during the first 10 d of their menstrual cycle.
- Treatment with prokinetic agents (metoclopramide [Reglan; ANI Pharmaceuticals Inc.], tegaserod [Zelnorm; Alfasigma USA, Inc.], domperidone [Motilium; Janssen], and erythromycin) should be stopped 2 d before the test unless the test is being performed to assess the efficacy of these drugs.

Identity	Dose	Route
^{99m} Tc-sulfur colloid	18.5 MBq (0.5 mCi); range, 18.5–37 MBq (0.5–1.0 mCi)	Oral bolus
^{99m} Tc-diethylenetriaminepentaacetic acid	18.5 MBq (0.5 mCi); range, 18.5–37 MBq (0.5–1.0 mCi)	Oral bolus
Pediatric dose: ^{99m} Tc-sulfur colloid	No weight-based dose; minimum administered activity, 9.25 MBq (0.25 mCi); maximum administered activity, 37 MBq (1.0 mCi)	Oral bolus

TABLE 1

Radiopharmaceutical Identity, Dose, and Route of Administration

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- Medications that delay gastric emptying should be stopped 2 d before the test. These include opiates (meperidine, codeine, morphine, oxycodone hydrochloride, and oxycodone acetaminophen), antispasmodic agents (dicyclomine, phenobarbital, hyoscyamine sulfate, glycopyrrolate), atropine, nifedipine, progesterone, octreotide, theophylline, benzodiazepines, and phentolamine.
- A focused history containing the following elements should be obtained:
 - Symptoms such as nausea, vomiting, abdominal pain, or early satiety.
 - Related diseases, such as hiatal hernia, gastroesophageal reflux, esophageal motility disorders, diabetes, infections, neuromuscular disorders, autoimmune disorders, and connective tissue disorders (previous interventions, including prior stomach or abdominal surgery, because previous surgery may alter the shape or route of emptying; medications as listed above).

PROTOCOL/ACQUISITION INSTRUCTIONS

- Radiopharmaceutical identity, dose, and route of administration are provided in Table 1.
- Planar acquisition parameters are provided in Table 2.
- Acquisition instructions:
 - Mix 18.5–37 MBq (0.5–1.0 mCi) of ^{99m}Tc-sulfur colloid or ^{99m}Tc-diethylenetriaminepentaacetic acid in 300 mL of water (substitution of juice, milk, or formula based on patient and clinical indication is permitted).
 - Instruct the patient to drink the liquid rapidly through a straw.
 - \circ Position the patient semiupright (30°-45° angle) with the camera in the left anterior oblique position and the stomach and upper abdomen in the field of view.
 - Obtain dynamic images at 60 s/frame for 30 min.

IMAGE PROCESSING

- Draw regions of interest around the activity in the entire stomach on the left anterior oblique view.
- Generate a time-activity curve.

TABLE 2Planar Acquisition Parameters

Parameter	Standard
Field of view	Large and small
Energy peak	140 keV
Energy window	20%
Collimator	Low-energy high-resolution
Patient position	Semiupright (30°–45°)
Camera position	Left anterior oblique
Time of imaging after ingestion	Immediate
Acquisition type	Dynamic
View	Left anterior oblique
Additional views	Not applicable
Matrix	128×128
Number of views	Not applicable
Time per view	60 s/frame for 30 min
Additional view time per projection	Not applicable

- Calculate half-emptying time (time required for emptying half the liquid) and best-fit mathematic exponential emptying rate. The normal halfemptying time for clear liquids is less than 25 min. Adding salt, sugar, or other caloric content to the clear liquid meal slows the emptying rate.
- Do not account for radioactive decay or correct for attenuation; these are unnecessary for liquid gastric emptying studies.

REFERENCES

- ACR-ACNM-SNMMI-SPR practice parameter for the performance of gastrointestinal tract, hepatic, and splenic scintigraphy. https://www.acr.org/-/media/ACR/ Files/Practice-Parameters/GI-Scint.pdf. Revised 2020. Accessed January 12, 2024.
- Banks KP, Syed K, Parekh M, McWhorter N. Gastric emptying scan. National Center for Biotechnology Information website. https://www.ncbi.nlm.nih.gov/books/ NBK531503/. Updated September 4, 2023. Accessed January 12, 2024.
- Maurer AH. Gastrointestinal motility, part 1: esophageal transit and gastric emptying. J Nucl Med Technol. 2016;44:1–11.
- Tempesta D. Gastrointestinal system. In: Gilmore D, Waterstram-Rich KM, eds. *Nuclear Medicine and PET/CT Technology and Techniques.* 9th ed. Elsevier Mosby; 2023:646–649.
- Ziessman HA, Chander A, Clarke J, Ramos A, Wahl R. The added value of liquid gastric emptying compared with solid emptying alone. *J Nucl Med.* 2009;50: 726–731.